



**US Army Corps
of Engineers®**

Engineer Research and
Development Center

Thermal Storage Cooling Systems

Description

The Construction Engineering Research Laboratory (CERL) offers a range of energy engineering expertise and consulting services related to thermal storage cooling systems technologies. One such technology is “thermal storage cooling,” which can effectively reduce the electrical-demand charge for facility air-conditioning. These systems use electricity during off-peak hours to operate cooling plants that make and store ice or chilled water at night, which in turn is used to cool buildings during the next day’s peak hours. Diurnal Ice Storage (DIS) cooling systems store ice; Chilled Water Storage (CWS) cooling systems store chilled water.

Capabilities

CERL’s capabilities related to thermal storage cooling systems technologies range from concept studies to system operation:

- feasibility analysis
- design review
- acceptance testing
- performance analysis and troubleshooting.

To date, Army installation and Corps of Engineers’ District personnel have requested CERL assistance in reviewing and documenting the design, construction, and operational performance of these cooling systems in technology demonstrations at five Army sites. Researchers also provide design reference and perform follow-on analyses of system operation and performance to document system benefits and to help installation Directorate of Public Works (DPW) engineers further improve system performance.

Supporting Technology

CERL researchers offer expert knowledge and assistance in the design, installation, and operation of several types of commercially available ice storage tanks, ranging in size from 12 to 1200 ton-hours. The three different types of system design and operation are:

1. “Full storage” systems, which do not operate the chiller during the day because the storage system generates and stores enough ice or chilled water to cool the building during the on-peak period.
2. “Partial storage” systems, in which the chiller operates continuously during the day and the storage system meet the additional cooling requirement during on-peak hours.
3. “Demand limiting” systems, in which the chiller turns off during the selected window of the peak period when rates are the highest. Most typically, demand limiting systems are the most cost-effective applications for Army installations.



Chilled Water Storage Cooling System at Fort Jackson, SC.

Benefits/Savings

Thermal storage cooling technology reduces a facility's peak electrical-demand charge for air-conditioning by transferring load to off-peak hours. DIS cooling systems for air-conditioning reduce the amount of electricity used during utility peak hours, thus reducing electrical-demand charges. In many instances, the demand charge constitutes as much as 50 percent of the electrical utility bill.

Success Stories

CERL has demonstrated four generic types of DIS technology: (1) an internal melt ice-on-coil system, (2) an external melt ice-on-coil system, (3) an ice harvesting system, and (4) an ice-ball system. A stratified CWS cooling system was also demonstrated. In October 1988, an external melt ice-on-coil DIS cooling system was retrofitted to a barracks/office/dining hall complex at Yuma Proving Ground, AZ. The system has reduced on-peak electrical demand there by 150 kW. The Arizona Public Service provided CERL with \$37,500 to fund the Yuma system as part of the utility's thermal storage incentive program. The system continues to operate as designed. The success of the system was featured in a 1993 videotape as part of the Facilities Engineering Applications Program.

In October 1996, a 30,000-gal storage tank was installed as a part of an ice-ball DIS cooling system, with 125,000 dimpled plastic balls with water inside to be frozen during the off-peak hours at CERL in Champaign, IL. The system has been serving CERL main building (130,000 sq ft), shifting over 200 kW from on-peak to off-peak hours since the 1997 cooling season. The yearly savings is calculated to be \$15,000 in the electrical utility bills. As a part of cool storage demonstration program for its customers, Illinois Power contributed \$50,000 for the preliminary study at CERL.

A 2.25M-gal CWS cooling system has been in operation at Central Energy Plant No.2 at Fort Jackson since May 1996. The measured system performance includes a shift of 3,450 kW from on-peak to off-peak hours, resulting in annual electrical savings of \$430,000 during the 1996-97 year. Central Energy Plant No. 2 at Fort Jackson, designed by the U.S. Army Corps of Engineers, has been designated as a 1997 Federal Energy Saver Showcase facility.

CERL-supported thermal storage cooling systems have yielded notable cost savings. A DIS cooling system installed at Fort Stewart, GA reduced the base electrical-demand charge by about \$10,000 per year. The system at Fort Bliss, TX has saved \$12,000 per year in demand charges. Annual savings from the DIS system at Yuma Proving Ground, AZ, amount to about \$22,450. Annual savings for a larger CWS system at Fort Jackson, SC, were calculated to be \$430,000 during 1996-97.

ERDC POC

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